21st March, 2001

International Patent Application PCT/EP00/00994

Gesellschaft für Schwerionenforschung mbH

New claim 1

1. Method for the verification of a calculated radiation dose of a heavy ion beam therapy system,

wherein the heavy ion beam therapy system comprises:

- at least one ion source (1) for heavy ions such as carbon ions,
- an accelerator device (2, 5) for the acceleration of the ions of the ion source (1) in the form of a treatment beam (11),
- a beam guidance system (6, 8), to guide the treatment beam (11) from the accelerator device (2, 5) to at least one irradiation site for treatment of a patient, the beam guidance system (6, 8) comprising at least one beam guidance channel (6), and
- a grid scanner device, arranged in the beam guidance system (6, 8), having vertical deflection means (13) and horizontal deflection means (14) for the vertical and horizontal deflection of the treatment beam (11) perpendicular to its beam direction, with the result that the treatment beam (11) is deflected by the grid scanner device to an isocentre (10) of the irradiation site and scans a specific area surrounding the isocentre (10), and

wherein irradiation is carried out on the basis of calculated radiation dose data,

characterised in that

the accuracy of the calculation of the radiation dose data is verified by using a phantom with the aid of the following steps:

a) the radiation dose data are calculated for a plurality of specific measurement points in the phantom,

b) irradiation of the phantom is carried out using the calculated radiation dose, and at the measurement points the radiation dose brought about there is measured, values ascertained by ionisation chambers being converted into energy dose values for verification of the calculated dose values,

c) the discrepancy between the radiation dose calculated for the measurement points and the radiation dose measured for the measurement points is determined, and

d) it is concluded that the accuracy of the calculation of the radiation dose data is adequate if the average discrepancy, for all the measurement points, between the calculated and the measured radiation dose values does not exceed a predetermined first tolerance value of ±5 % and, for each individual measurement point, the discrepancy between the radiation dose calculated and measured for that measurement point does not exceed a predetermined second tolerance value of ±7 %.

2. Method according to claim 1,
characterised in that
in step b) the radiation dose is measured with the aid of an appropriately positioned ionisation chamber.

Sub A1

3. Method according to claim 1 or claim 2,
characterised in that
the accuracy of the calculation of the radiation dose data is verified, for a homogeneous medium to be irradiated, by using a water phantom.

4. Method according to one of the preceding claims,
characterised in that
the accuracy of the calculation of the radiation dose data is verified, for a non-homogeneous medium to be irradiated, by using a solid-body phantom having non-homogeneities.

5. Method according to claim 4,
characterised in that
the solid-body phantom is spherical and consists of a water-equivalent material.

Sub A2

6. Method according to claim 4 or 5,
characterised in that
different non-homogeneities are interchangeably inserted in the solid-body phantom.

7. Method according to one of claims 4-6,
characterised in that
the steps a)-d) are carried out for at least three different non-homogeneity structures of the solid-body phantom, the first solid-body phantom having boundary layers between different

Sub a2

materials, the second solid-body phantom having thin non-homogeneities and the third solid-body phantom having thick non-homogeneities.

8. Method according to one of the preceding claims,
characterised in that
the accuracy of the calculation of the radiation dose data is verified by using an irregularly shaped phantom.

9. Method according to claim 8,
characterised in that
the irregularly shaped phantom consists of a water-equivalent material and has the shape of a human head.

Sub a3

10. Method according to one of the preceding claims,
characterised in that
a digital reconstruction of the phantom is calculated;
an image of the phantom is produced and compared with the calculated reconstructions to ascertain a discrepancy; and
it is concluded that there is an error in the calculation of the digital reconstructions if the discrepancy between the calculated reconstructions and the corresponding image exceeds a specific tolerance limit value.

11. Method according to claim 10,
characterised in that
a plurality of digital X-ray reconstructions of the phantom are calculated; and
X-ray images of the phantom are produced from a plurality of imaging directions and individually compared with the corresponding X-ray reconstructions.

Sub a4

12. Method according to claim 10 or 11,
characterised in that
the tolerance limit value is 2 mm.